CLAIMS

1. A battery cell, comprising:

an active metal anode having a first surface and a second surface;

a cathode structure comprising an electronically conductive component, an ionically conductive component, and an electrochemically active component, wherein at least one cathode structure component comprises an aqueous constituent;

an ionically conductive protective membrane on the first surface of the anode, the membrane comprising,

one or more materials configured to provide a first surface chemically compatible with the active metal of the anode in contact with the anode, and a second surface substantially impervious to and chemically compatible with the cathode structure and in contact with the cathode structure.

2. The cell of claim 1, wherein the cathode structure comprises an aqueous electrochemically active component.

3. The cell of claim 2, wherein the aqueous electrochemically active component is water.

4. The cell of claim 2, wherein the aqueous electrochemically active component comprises a water soluble oxidant selected from the group consisting of gaseous, liquid and solid oxidants and combinations thereof.

5. The cell of claim 4, wherein the water soluble gaseous oxidants are selected from the group consisting of O_2, SO_2 and NO_2, and the water soluble solid oxidants are selected from the group consisting of $NaNO_2$, KNO_2, Na_2SO_3 and K_2SO_3.

6. The cell of claim 4, wherein the water soluble oxidant is a peroxide.

7. The cell of claim 6, wherein the water soluble oxidant is hydrogen peroxide.

8. The cell of claim 1, wherein the ionically conductive component and the electrochemically active component are comprised of an aqueous electrolyte.

9. The cell of claim 8, wherein the aqueous electrolyte is selected from the group consisting of strong acid solutions, weak acid solutions, basic solutions, neutral solutions, amphoteric solutions, peroxide solutions and combinations thereof.

10. The cell of claim 8, wherein the aqueous electrolyte comprises members selected from the group consisting of aqueous solutions of HCl, H_2SO_4, H_3PO_4 acetic acid/Li acetate, LiOH; sea water, LiCl, LiBr, LiI, NH_4Cl, NH_4Br and hydrogen peroxide, and combinations thereof.

11. The cell of claim 10, wherein the aqueous electrolyte is sea water.

12. The cell of claim 10, wherein the aqueous electrolyte comprises sea water and hydrogen peroxide.

13. The cell of claim 9, wherein the aqueous electrolyte comprises an acidic peroxide solution.

14. The cell of claim 9, wherein hydrogen peroxide dissolved in aqueous electrolyte flowing through the cell.

15. The cell of claim 2, wherein the cathode structure electronically conductive component is a porous catalytic support.

16. The cell of claim 15, wherein the porous catalytic electronically conductive support is reinforced.

17. The cell of claim 15, wherein the porous catalytic electronically conductive support comprises nickel.

18. The cell of claim 15, wherein the porous catalytic electronically conductive support comprises an inert material impregnated with a water reducing catalyst.

19. The cell of claim 15, wherein the porous catalytic electronically conductive support is treated with an ionomer.

20. The cell of claim 2, wherein the cell has an open cell voltage of at least 2 V.

21. The cell of claim 12, wherein the cell has a flat discharge potential of at least 3.5 V.

22. The cell of claim 14, further comprising a separator disposed between the protective membrane and the cathode structure.

23. The cell of claim 1, further comprising a PEM H_2/O_2 fuel cell to capture hydrogen released from the cathode structure in the battery cell redox reaction.

24. The cell of claim 1, wherein the cathode structure electrochemically active material comprises air.

25. The cell of claim 24, wherein the air comprises moisture.

26. The cell of claim 25, wherein the ionically conductive material comprises an aqueous constituent.

27. The cell of claim 26, wherein the ionically conductive material further comprises an ionomer.

28. The cell of claim 26, wherein the ionically conductive material comprises a neutral or acidic aqueous electrolyte.

29. The cell of claim 28, wherein the aqueous electrolyte comprises LiCl.

30. The cell of claim 28, wherein the aqueous electrolyte comprises one of NH_4Cl, and HCl.

31. The cell of claim 24, wherein the cathode structure comprises an air diffusion membrane, a hydrophobic polymer layer, an oxygen reduction catalyst, an electrolyte, and an electronically conductive component/current collector.

32. The cell of claim 24, wherein the electronically conductive component/current collector comprises a porous nickel material.

33. The cell of claim 24, wherein the cell has an open cell voltage of at least 3 V.

34. The cell of claim 24, wherein the cell has a flat discharge potential of about 2.9 V at a discharge rate of 0.3 mA/cm^2 for at least 25 hours.

35. The cell of claim 24, wherein the cell has a discharge capacity of at least 10 mAh/cm^2.

36. The cell of claim 32, further comprising a separator disposed between the protective membrane and the cathode structure.

37. The cell of claim 1, wherein the cathode structure electrochemically active component comprises a metal hydride alloy.

38. The cell of claim 37, wherein the cathode structure ionically conductive component comprises an aqueous electrolyte.

39. The cell of claim 38, wherein the aqueous electrolyte is acidic.

40. The cell of claim 39, wherein the aqueous electrolyte comprises a halide acid or acidic salt.

41. The cell of claim 40, wherein the aqueous electrolyte comprises a chloride or bromide acid or acidic salt.

42. The cell of claim 41, wherein the aqueous electrolyte comprises one of HCl, HBr, NH_4Cl and NH_4Br.

43. The cell of claim 37, wherein the metal hydride alloy comprises one of an AB_5 and an AB_2 alloy.

44. The cell of claim 1, wherein the active metal is lithium.

45. The cell of claim 44, wherein wherein the cathode structure comprises an aqueous electrochemically active component.

46. The cell of claim 44, wherein the cathode structure electrochemically active material comprises air.

47. The cell of claim 44, wherein the cathode structure electrochemically active component comprises a metal hydride alloy.

48. The cell of claim 1, wherein the ionic conductivity of the protective membrane is at least 10^{-7} S/cm.

49. The cell of claim 1, wherein the ionic conductivity of the protective membrane is at least 10^{-5} S/cm.

50. The cell of claim 1, wherein the ionically conductive protective membrane comprises a composite, the composite comprising,

a first material component in contact with the anode that is ionically conductive and chemically compatible with the active metal of the anode, and

a second material component in contact with the first material component, the second material being substantially impervious, ionically conductive and chemically compatible with the first material component and the cathode structure.

51. The cell of claim 50, wherein the protective composite is a laminate.

52. The cell of claim 50, wherein the protective composite is graded.

53. The cell of claim 50, wherein the active metal of the negative electrode is lithium or a lithium alloy.

54. The cell of claim 50, wherein the first component comprises a material selected from the group consisting of active metal nitrides, active metal phosphides, and active metal halides, and active metal phosphorus oxynitride glass.

55. The cell of claim 50, wherein the first layer comprises a material selected from the group consisting of Li_3N, Li_3P and LiI, LiBr, LiCl, LiF, and LiPON.

56. The cell of claim 50, wherein the second component comprises a material selected from the group consisting of glassy or amorphous metal ion conductors, ceramic active metal ion conductors, and glass-ceramic active metal ion conductors.

57. The cell of claim 50, wherein the second component is an ion conductive glass-ceramic having the following composition:

Composition	mol %
P_2O_5	26-55%
SiO_2	0-15%
$GeO_2 + TiO_2$	25-50%
in which GeO_2	0--50%
TiO_2	0--50%
ZrO_2	0-10%
M_2O_3	0 < 10%
Al_2O_3	0-15%
Ga_2O_3	0-15%
Li_2O	3-25%

and containing a predominant crystalline phase composed of $Li_{1+x}(M,Al,Ga)_x(Ge_{1-y}Ti_y)_{2-x}(PO_4)_3$ where $X \leq 0.8$ and $0 \leq Y \leq 1.0$, and where M is an element selected from

the group consisting of Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm and Yb and/or and $Li_{1+x+y}Q_xTi_{2-x}Si_yP_{3-y}O_{12}$ where $0< X\leq 0.4$ and $0< Y\leq 0.6$, and where Q is Al or Ga.

58. The cell of claim 1, wherein the cell is a primary cell.

59. The cell of claim 1, wherein the cell is a rechargeable cell.

60. The cell of claim 1, wherein the cell has a planar configuration.

61. The cell of claim 60, wherein the cell is bonded into a flexible array of like cells by elastomeric seals.

62. The cell of claim 1, wherein the cell has a tubular configuration.

63. The cell of claim 1, wherein the cell comprise a capillary construction.

64. The cell of claim 1, wherein the active metal is lithium and the cathode structure comprises an aqueous ionically conductive component and a transition metal oxide electrochemically active component.

65. The cell of claim 64, wherein the a transition metal oxide is selected from the group consisting of NiOOH, AgO, iron oxide, lead oxide and manganese oxide.

66. A electrochemical cell structure, comprising:

an active metal anode having a first surface and a second surface;

a porous catalytic electronically conductive support;

an ionically conductive protective membrane on the first surface of the anode, the membrane comprising,

one or more materials configured to provide a first surface chemically compatible with the active metal of the anode, and a second surface substantially impervious to and chemically compatible with the catalytic electronically conductive support, and aqueous environments.

67. A method of making an electrochemical cell structure, comprising:

assembling an active metal anode and a cathode structure comprising an electronically conductive component;

wherein a protective membrane is disposed between the active metal anode and the cathode structure, the membrane being ionically conductive and chemically

compatible with an active metal on a first side, and substantially impervious, ionically conductive and chemically compatible the cathode structure on the other side;

and wherein an active metal material is applied to the first side of the protective membrane to form the active metal anode.

68. The method of claim 67, wherein the electronically conductive component of the cathode structure is a porous nickel sheet.

69. The method of claim 67, wherein the cathode structure further comprises an ionically conductive component, and an electrochemically active component, wherein at least one cathode structure component comprises an aqueous constituent, and the electrochemical cell structure is a battery cell.